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AGRICULTURAL MEMORANDUM No 1100

THE THERMAL CLIMATE OF A LARGE, DISUSED, SAND QUARRY

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Abstract:

Hourly air temperatures recorded in a large, disused sand quarry, 25 m below the level of the surrounding land, in the Cheshire Plain, showed only minor differences from those recorded at the nearby meteorological office at Ringway. Hours of air frost were also very similar.

Daily maximum and minimum air temperatures in the quarry were very similar to those recorded at the Knutsford climatological site, 8 km distant.

Signs of local cold air drainage were evident in the slightly enhanced rates of cooling later in the day, and the sheltered aspect was considered responsible for the sightly increased rates of warming during the morning.

The net effect suggests that, on purely temperature considerations, there are no grounds on which to limit the normal selection of crops which may be grown in the quarry.

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Introduction:

By convention old quarry sites are used for waste disposal, recreation or wildlife habitat. The Acre Nook West sand quarry near Chelford, Cheshire (see fig 1) covers an area of 50 hectares. It is the largest of its kind in the county and offers the additional option of low-level restoration* to agricultural use. However, the restored land would be around 25 m below the level of the surrounding countryside, and would include an area of water at the lower end, the level of which would have to be regulated by perpetual pumping.

Any large deviation from the normal thermal climate of the area would limit the choice of crops, but no quantifiable information on the likely climatic effects could be found in the literature.

A study was initiated to compare the air temperatures recorded on the floor of the quarry with hourly and daily records from long established met. sites in the same general area.

Method:

A mini-thermistor temperature probe was connected to a data logger (Grants Instruments, Cambridge) and exposed in a Stevenson screen 1.2 m above ground level. The underlying surface was around 70% covered by low growing wild plants with small copses of willow and silver birch in the middle distance. Hourly temperature recordings were taken to coincide with normal practice (10 minutes before the hour) for three, one month periods; 6 October - 5 November 1984 (ie "October"), 1-28 February 1985 and 1-31 August 1985. These hourly records were compared directly to those from Manchester Airport (Ringway), and also to the daily maximum and minimum air temperatures from Knutsford (see map, figure 1).

* restoration at a level below that of the surrounding countryside.

Results:

1. Comparison of hourly average temperatures

1.1 February

A direct comparison between the monthly mean temperatures at set hours from the quarry and Ringway during February 1985 showed similar temperatures between 00 and 1500 GMT (fig 3), but an increased rate of cooling between 1500 and 2100 GMT.

The average of the highest and lowest recorded hourly air temperatures each day are given in table 1.

Table 1. Average hourly, max and min air temperatures: February 1985 : °C

	Hour - GMT									
	00	03	06	09	12	15	18	21	Max*	Min*
Ringway	2.1	1.8	1.6	2.4	4.5	5.2	3.8	2.5	5.7	0.6
Quarry	2.0	1.9	1.5	2.5	4.5	5.2	3.3	2.0	5.6	0.1

* daily highest and lowest from the hourly records

February was colder and brighter than normal with several days of continuous sub-zero temperatures and prolonged easterly winds bringing snow: See Annex for more detail.

1.2 August

During August the hourly mean air temperatures are Ringway and the quarry were broadly similar between 00 and 0600 GMT. Between 0600 and 1200 GMT the temperature in the quarry increased more quickly, and conversely decreased more quickly between 1500 and 2400 GMT - see fig 3, table 2.

Table 2. Average hourly, max and min air temperatures: August 1985: °C

	Hour - GMT									
	00	03	06	09	12	15	18	21	Max	Min
Ringway	12.8	12.5	12.3	14.3	15.6	16.5	15.8	13.7	17.3	11.7
Quarry	12.7	12.5	12.5	14.7	16.2	16.7	15.8	13.3	17.4	11.4

August was a generally cool, cloudy month with a higher than normal number of rain days and well above normal wind speeds. Hence it was not an ideal month for producing differential temperature effects.

1.3 October

The air temperature trends in October were similar to those in August: table 3.

Table 3. Average hourly, max and min air temperatures: October 1984: °C

	Hour - GMT									
	00	03	06	09	12	15	18	21	Max	Min
Ringway	10.1	9.8	9.8	10.7	12.3	12.7	11.7	10.7	13.3	8.3
Quarry	10.1	10.0	9.8	11.2	12.8	13.1	11.5	10.8	13.9	8.2

October was a mild, wet month, but with near-normal sunshine hours and wind speeds.

2. Comparison of daily extreme temperatures

The comparison of the daily maximum and minimum air temperatures was extended to include readings from the Met. site at Knutsford, see table 4. Knutsford only records once a day readings of maximum and minimum temperatures so a correction had to be made to the quarry temperature to make them comparable. The correction was taken as the difference at Ringway between the mean daily maximum from a. the hourly recordings and b. the true maximum; and similarly for the minimum. The differences then applied to the quarry recordings varied from 0.1 to 0.6°C.

Table 4. Average daily maximum, minimum and mean air temperatures: °C

	February			August			October		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Quarry	5.7	-0.5	2.6	17.8	11.3	14.5	14.2	8.0	11.1
Ringway	5.8	0.0	2.9	17.7	11.6	14.7	13.6	8.1	10.9
Knutsford	5.9	-0.4	2.7	18.2	10.6	14.4	14.5*	7.6*	11.0*

* data missing 1-4*

The differences between the minimum temperatures each month between the quarry and Knutsford varies between -0.1 and +0.7°C, while the small but consistently higher night minimum at Ringway suggest an urban effect. The differences in maximum are small with Knutsford recording the highest each month.

3. Comparison of air frost hours, during February

During February, the total number of hours with sub-zero temperatures was tallied. Ringway recorded 195 hours while the quarry site recorded 192 hours. The lowest recorded air temperature in the quarry was -8.6°C (16/2/85), at Ringway -6.3°C (16/2/85) and at Knutsford -8.0°C (16/2/85).

Conclusions:

The absence of any hills in the area surrounding the quarry may be crucial because this will limit local air drainage into the quarry, and preclude any larger scale drainage completely.

Within this context the study revealed only minor differences in air temperature when compared to surrounding meteorological stations.

It must be added that the weather in August (cloudy and windy) would have minimised any differences, especially as to the extent of day-time heating.

In conclusion, from the temperature recordings studied thee are no grounds on which to limit the normal selection of crops which are suited to Cheshire generally.

Any comments or suggestions should be referred to the author.

Annex

Monthly Averages for Ringway

		Wind Speed knots	Sunshine hours	Max Temp °C	Min Temp °C	Rainfall mm
February	1985	8.2	82	5.8	0.0	10
	Normal	8.8	62	6.5	0.9	52
August	1985	10.0	127	17.7	11.6	76
	Normal	7.3	157	19.4	11.7	83
October	1984	8.6	94	14.2	7.9	97
	Normal	8.3	96	13.8	7.2	69

fig 1 site locations

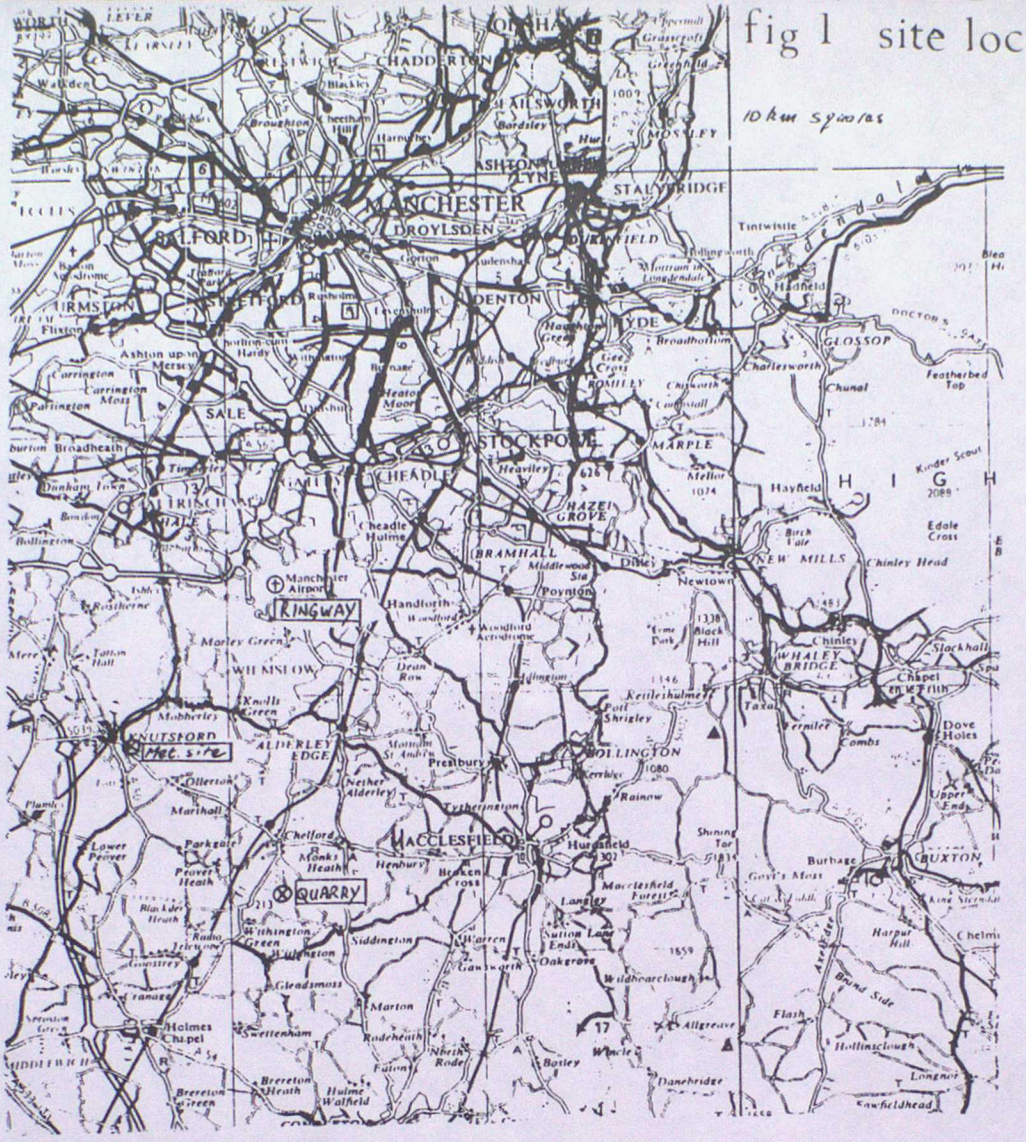
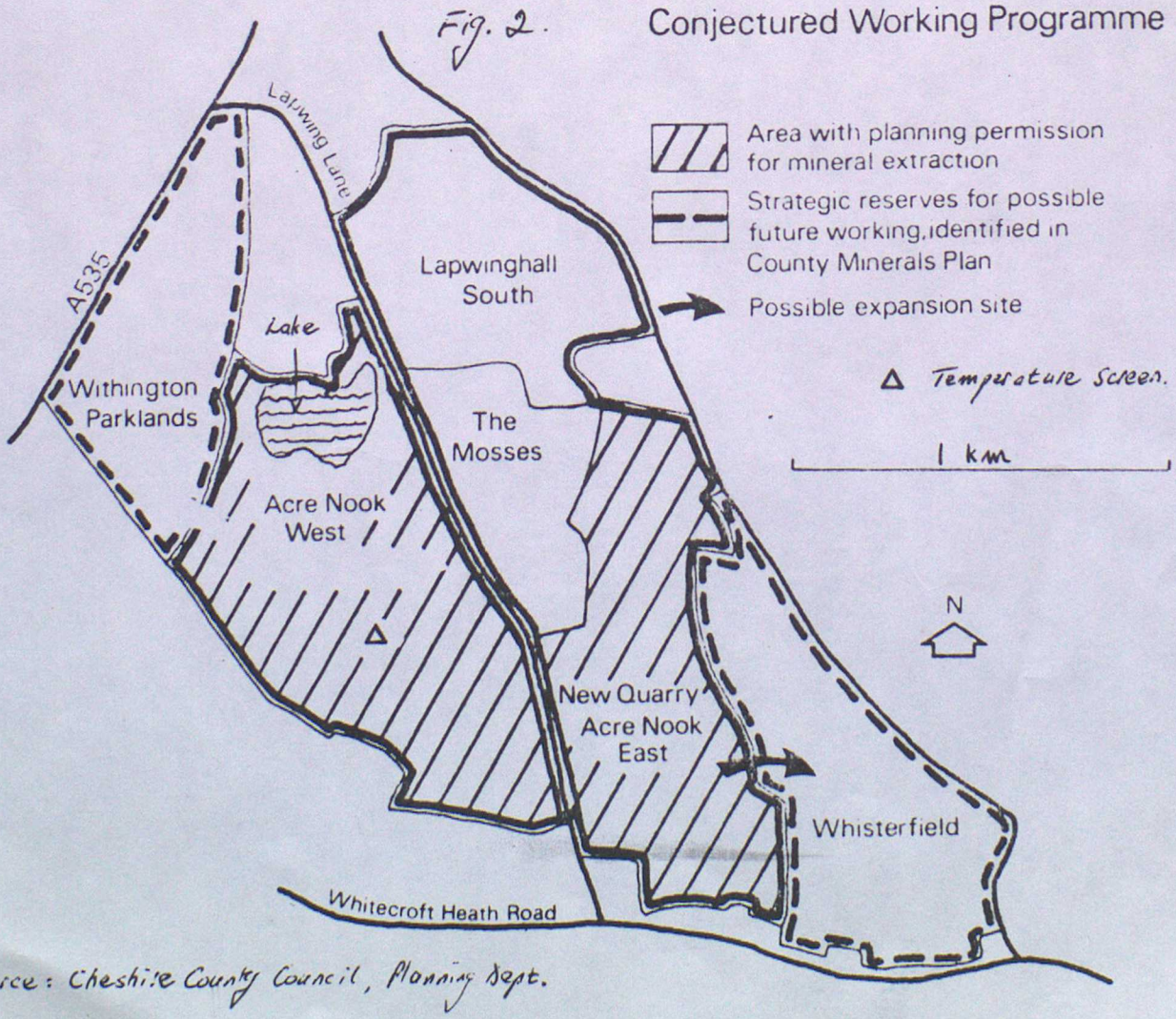


Fig. 2. Conjectured Working Programme



Source: Cheshire County Council, Planning Dept.

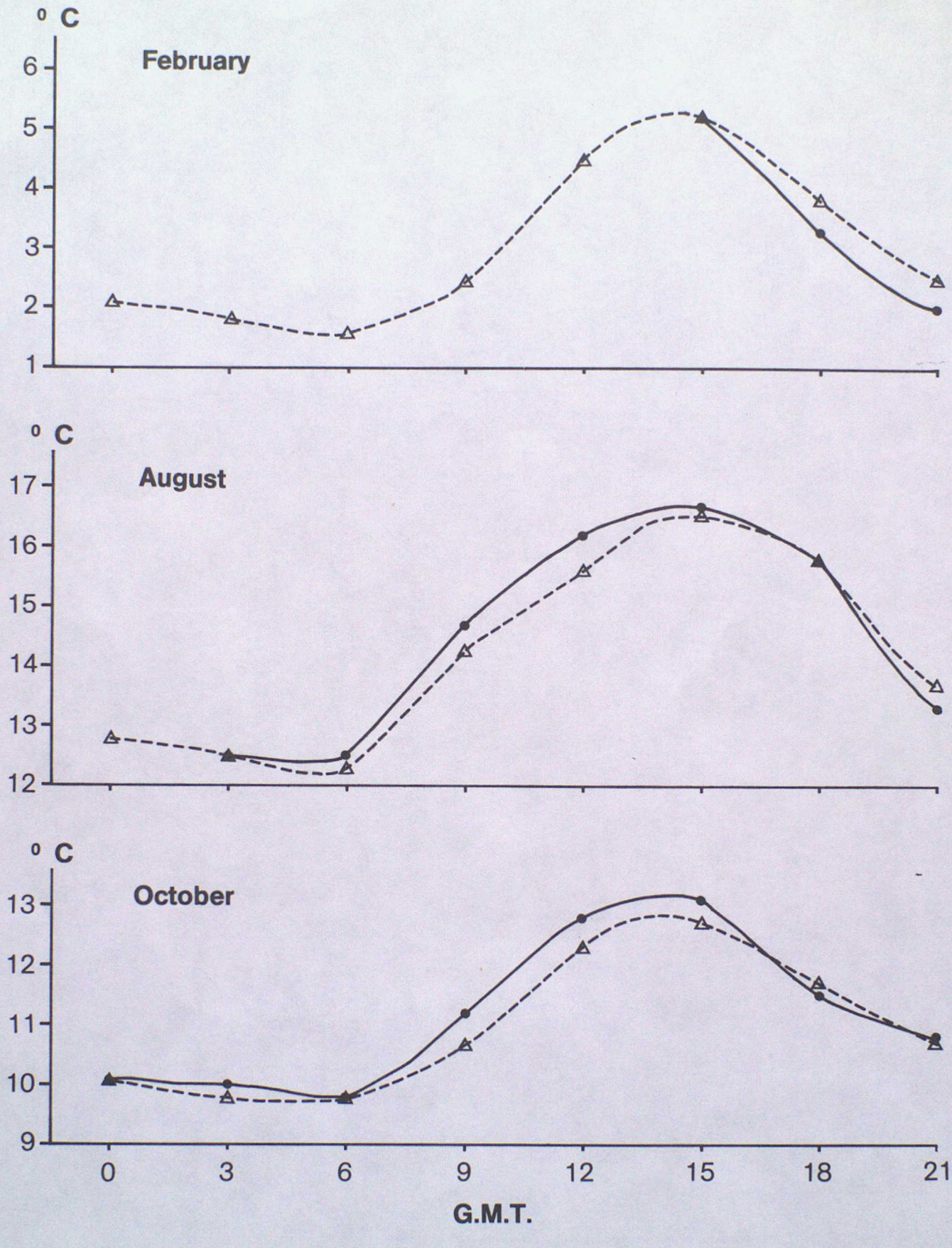


fig. 3 **MEAN HOURLY TEMPERATURES**